International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

EVALUATION OF HYBRID COUPLING BEAM(HCB) WITH SHEAR WALL IN MULTI-STOREY BUILDING

Anujith A[1], Mrs. Anila S[2]

[1]*Anujith A PG student*
[2]*Mrs. Anila S Assistant Professor*
[1,2]*Dept. of Civil Engineering, AWH college of engineering, Kerala, India*

---***---

Abstract - *The seismic performance of reinforced concrete (RC) shear wall structures can be significantly improved by hybrid coupling beams installed I sections with metallic dampers. The damper yields first during an earthquake, thus absorbing a large amount of energy, and protecting the RC part of the coupling beam. Parametric modeling and analysis of hybrid coupling beam(HCB) by varying depth and thickness. This study began by proposing a particular configuration of the I section installed with different slits. A parametric study was conducted in ANSYS on the frame-shear wall structural system by a nonlinear pushover analysis.*

***Key Words*: Hybrid coupling beam(HCB), parametric study of HCB, Pushover analysis of HCB, HCB prototype analysis, etc.**

1. INTRODUCTION

Coupled wall systems consist of separate structural walls linked together by coupling beams that are employed as an efficient structural system to resist lateral forces in medium and high-rise buildings. The behavior of coupled shear walls is mainly governed by the coupling beams. The coupling beams are designed for ductile inelastic behavior to dissipate energy. Modern buildings generally behave well in terms of life safety in terms of large earthquakes, However repair of these buildings is found to be costly in both money and time, one solution to achieve this is to use easily replaceable components or devices in the energy dissipation regions of the structure. This study deal with a steel member used alone or encased in concrete that is confined with varying levels of longitudinal and transverse reinforcement, resulting in a composite (steel-concrete) coupling beam. Steel beams have been shown to have outstanding energy dissipation.

2. MODELLING

Modeling of this project carried out in two phases, first design the beam using ETAB and mechanical properties of the coupling beam studied using ANSYS software.

2.1 Design of coupling beam

The plan of the 18-story frame-shear wall structure is shown in Fig.2.1. It was designed using ETAB software according to the Indian standard seismic code. The story height is 4.5m for the first story and 3.6m for the rest. The total height of the building is 65.7 m. The length and width of the building are 60.0m and 15.0 m, respectively. The aspect ratio is about 4.4 shown in table 1. The building is relatively weak in the Y-direction, where five frames and five coupled walls are established.

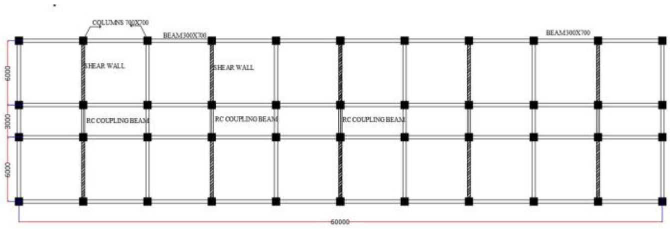

Fig 2.1 Plan of 18 storey building

Table -1: Detail of building.

Details of Building	4.5 m ground floor 3.6 m for rest of Storey
Material Properties of the Building	Columns 1-9 storey: M40 1-18 storey: M35 Beams : M30 Shear wall and coupling beam : 1-9 storey : M40 1-18 storey : M35 Grade of steel : Fe415
Sectional Properties of Building	Coupling beam: 1500 X 400 mm Beam dimension: 300X700 mm Coupling beam: 1500 X 360 mm Thickness of the shear wall: 360 mm Thickness of slab : 120 mm Column dimensions: 1 to 18 storeys : 700 x 700 mm

2.2 Design of prototype

For modeling in ANSYS prototype was modeled. One of the frames was selected from the structure, the physical dimensions of the frame are scaled 1/3 from the actual model, and the reinforcement was considered as per the percentage of A_{st} shown in table 2. ANSYS models of the prototype is shown in fig.2.2.

Table -2: Detail of building.

	Parameters	Actual model	Prototype
1	Length	27000mm	900mm
2	Height	1500mm	500mm
3	Thickness	360 mm	120mm
4	Longitudinal rebar	Top 4 Nos 25mm dia bars Middle 4 Nos of 25mm dia bars Bottom 4 Nos 25mm dia bars	Corners 4 Nos 12mm bars Middle 4 Nos 8mm bars
5	Vertical tie	10 mm dia bars @ 80mm spacing	8mm dia bars @ 100mm spacing
6	Length coupling beams were extended into the wall	600 mm at the middle	200 mm at the middle

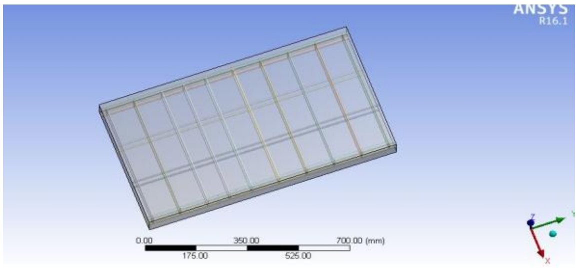

Fig 2.2 ANSYS model of the prototype

2.3 Parametric analysis of I section

To improve the engineering properties of the coupling beam section I section is provided in the middle of the RC section. Parametric analysis was done using a I section (W300) with 300mm web depth,50mm flange width,5mm web thickness and 10mm flange thickness. Push load applied in terms of 30mm displacement through the loading axis of the hybrid model section shown in fig 2.3. In this analysis W300 model behaves better than the RC section tabulated in table 3.

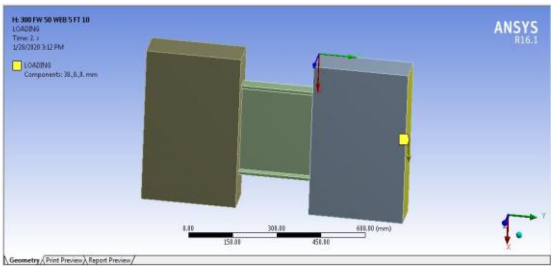

Fig 2.3 ANSYS model W300 section with the loading phase

Table -3: Result of the parametric study.

PARAMETER	RC	W300
The thickness of flange (mm)		10
The breadth of a flange (mm)		50
The thickness of the web (mm)		5
Height of the web (mm)		300
Yield Displacement (mm)	1.2	1.5
Yield load (kN)	107.3	200.9
Yield Stifness (kN/mm)	90	133.93

W300 model is taken as an effective section with133.33 kN/mm stiffness. For reducing the stiffness to range of RC section an area is cut-off from the web section which will enhance the ductility of the section. For finding the optimum cut-off area 11.06%,15.6%,20%, and 24.5% web area is the cut-off and results are tabulated in table 4. In this study conclude that 20% cut-off area was best. fig 2.4 Shows the 20% cut-off area analyzed section.

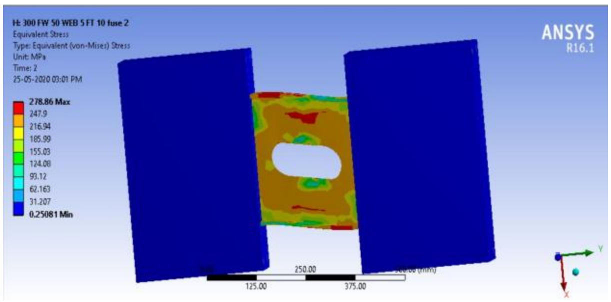

Fig 2.4 Shows the 20% cut-off area analyzed section.

Table -4: Result of the cut-off area study.

Model	Yield displacement (mm)	Yield load(kN)	Stiffness(kN/mm)
F11.0%	0.8	95.50	73.40
F15.8%	0.8	106.55	118.75
F20%	1.35	117	86.67
F24.5%	0.8	70.117	87.64

20% of the cut-off area is giving required result in stiffness, the area is assigned as oval, circle and slit format in web section and analyzed the result is tabulated in table 5 and cut-off area arrangements shown in Fig 2.5

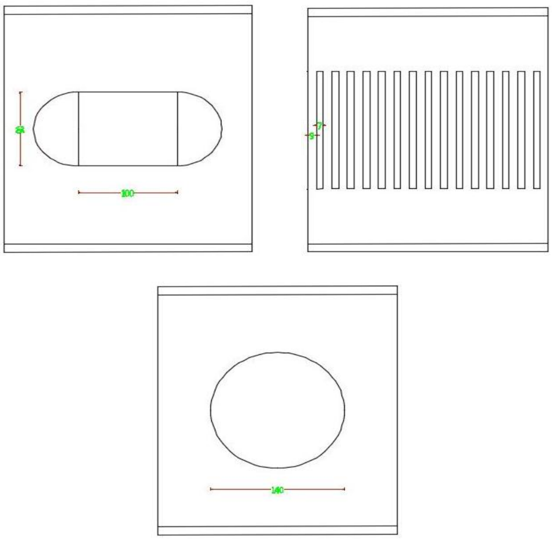

Fig 2.5 The cut-off area shapes

Table -4: Result of different cut-off area shapes

Model	Yield displacement (mm)	Yield load (kN)	Stiffness (kN/mm)
OVAL	1.35	117	86.67
CIRCLE	0.8	82.44	103.05
SLITS	0.8	39.97	49.96

A circle has 103.05 kN/mm which is larger than the RC section so the failure is concentrated at the concrete part. The oval cut-off area has 86.67 kN/mm yield stiffness that is 3% less than the RC section and has 117 kN load should be taken before the section is yield. Fig 2.4 shows the stress intensity concentration of the OVAL cut-off section, Fig 2.6 shows the stress intensity concentration of slit cut-off section.

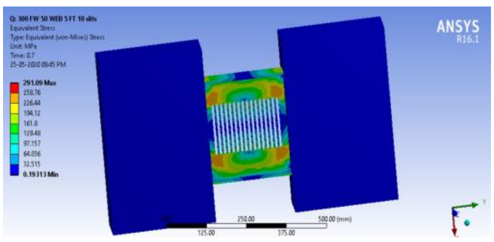

Fig 2.6 Shows the stress intensity concentration of slit cut-off section

3. CONCLUSIONS

Shear walls are mainly contributing stability against lateral forces like ground motion, wind forces, etc. In this paper, 18 storey building with five shear walls and five coupling beam were designed using ETAB. To improve the ductility properties of the coupling beam an I-section is introduced in between this beam and acts as an energy dissipater and will get more time to escape life before the building is failed. The paper concludes that,

1) 18 storey building is modeled and designed using ETAB.
2) RC Coupling beam prototype was modeled and show a stiffness 90.55 kN/mm.
3) Parametric modeling and analysis of hybrid coupling beam(HCB) by varying depth and thickness were done. The resulting model with 300mm web height, 5mm thickness, and 50mm flange width, 10mm thickness having stiffness 133.3 kN/mm.
4) For reducing the stiffness in the range of the RC model provide a 20.4% cut off area, by analyzing the 20.4% cut-off area with different shapes, the oval shape is found performed better.

REFERENCES

[1] Junhua Wang and Hua Zhao "High-Performance Damage-Resistant Seismic Resistant Structural Systems for Sustainable and Resilient City: A Review(2018)," at Key Laboratory of Geohazard Prevention and Geoenvironment Protection, Chengdu University of Technology,

[2] Xiaodong Jia, Dan Liua, Carlos Molina Huttb "Seismic performance evaluation of a high-rise building with a novel hybrid coupled walls" at Key Laboratory of Civil Engineering Safety and Durability of China Education Ministry, Tsinghua University, Beijing (2018)

[3] Reshma Chandran, " Comparative study on solid and coupled shear wall(2014)" at Journal Impact Factor

[4] Tao Wang, Qingxue Shang, Xiaoting Wang, Jichao Li, Zi'ang Kong, "Experimental validation of RC shear wall structures with hybrid coupling Beams(2018)" Soil Dynamics and Earthquake Engineering 111

[5] Yun Chen State"New Replaceable Coupling Beams for Shear Wall Structures(2012)" laboratory of Disaster Reduction in Civil Engineering, Tongji University, Shanghai, China, wcee15